THROMBOPLASTIN REAGENT AND METHOD FOR MANUFACTURING THE SAME

Background of the Invention

1. Field of the Invention

The present invention relates to a thromboplastin reagent used for measurement of a coagulation factor where a novel reagent having high sensitivity is provided and also relates to a method for manufacturing the same.

2. Description of the Related Art

As a test for screening the defect of coagulation factors in the blood of patients, Quick's Prothrombin time (PT) has been used. PT is also used as a monitor for the therapy by oral anticoagulant therapy. Although measurement of the PT varies depending upon the property of the thromboplastin reagent, PT of normal blood donor is 10-14 seconds and, with regard to the PT of plasma deficient in coagulation factors, it is preferred to use a thromboplastin reagent which is prepared in such a manner that the PT can be prolonged depending upon the degree of defect of the coagulation factor.

Active thromboplastin induces the coagulation in plasma and is composed of a lipid component and a protein component. Protein, i.e. the tissue factor, is bonded to membrane and is found in many various tissues. The bond between the protein and the lipid is independent on Ca^{2+} due to a hydrophobic interaction. Protein residue comprises glycoprotein having a

molecular weight of 43-53 kDa. One molecule of the tissue factor is able to bond to one molecule of a coagulation factor VII or a coagulation factor VIIa. Bond of the coagulation factor VII/coagulation factor VIIa to the tissue factor is dependent on Ca^{2+}. A complex comprising lipid, tissue factor and coagulation factor VIIa cleaves a coagulation factor X to form a coagulation factor Xa whereby blood coagulation by the activated prothrombin is finally induced.

Initiation of coagulation in plasma after 10-14 seconds from addition of a thromboplastin reagent indicates that the coagulation system is unhurt. An increase in the coagulation time causes a certain disorder. The disorder occurs as a result of too low concentration of one or more coagulation factor(s).

Thromboplastin can be extracted from many kinds of tissues of various animal materials. Due to the limited availability, the cost thereof, etc., materials which are generally utilized are limited and thromboplastin derived from rabbit brain which is the most common material has a relatively low sensitivity as compared with thromboplastin derived typically from human tissues. Materials, extracting method and reagent composition for thromboplastin are important factors for determining the sensitivity of the reagent. Under such circumstances, in order to improve the sensitivity of thromboplastin, investigation for extraction using a nonionic detergent or the like has been attempted and reported (Japanese

Patent Laid-Open No. 03/503534).

As to another method for improving the sensitivity, there has been reported a method where a small amount of protein is specifically removed. It is often that thromboplastins of various origins are different in terms of their sensitivity indicating the defect of specific coagulation factors. In some cases, that is due to the fact that a small amount of the factor to be measured is brought into the reagent.

For example, there is a report for a method of improving the sensitivity by a selective inhibition of coagulation factor VII/coagulation factor VIIa remaining in the thromboplastin reagent (Japanese Patent Laid-Open No. 10/330,400).

For the measurement of a more correct coagulation time, standardization of the PT measurement has been carried out. For such a purpose, a standard sample of a thromboplastin reagent is prepared, sensitivity of each reagent is expressed in terms of international sensitivity index (hereinafter, referred to as "ISI") on the basis of the above and that is described for each reagent.

When PT is measured using a thromboplastin reagent, ISI value becomes low when the difference between the PT of normal human plasma and the measured PT of plasma deficient in coagulation factor is big while, when the said different is small, ISI value becomes high. Accordingly, the ISI value of a thromboplastin reagent having high measurement sensitivity

is low and there has been a demand for such a reagent. The ISI value of the international standard preparation of thromboplastin is 1.0.

However, as mentioned already, property of a thromboplastin reagent varies depending upon the material composition therefor. For example, the property differs when the material is derived from human being, rabbit or bovine. There are many cases where there is prepared a composition containing a thromboplastin showing an ISI value of more than 1.0.

Further, in some cases, a step of freeze-drying treatment during the manufacturing steps of a thromboplastin reagent affects the measurement of the coagulation time. Thus, when the PT is measured using the said freeze-dried thromboplastin reagent, there are some cases where it is longer than 14 seconds even when normal plasma is used and such a phenomenon results from a freeze-drying process. The use of a thromboplastin reagent showing a value of longer than 14 seconds in the case of normal plasma is not preferred in view of efficiency of the measurement and there has been also a demand for development of a manufacturing method whereby the damage by freeze-drying failure is excluded.

Summary of the Invention

The matter to be solved by the present invention is to

provide a novel thromboplastin reagent having high measurement sensitivity.

The present inventors have carried out an intensive investigation by paying their attention to the ISI value and have found that, when amino acid or amino acid derivative is added to a thromboplastin-containing composition having an ISI value of more than 1.0, there are some cases where the ISI value becomes nearer 1.0. The present invention has been achieved by addition of amino acid or amino acid derivative having such a function in an effective amount to thromboplastin. It has been further investigated for the stage when such an amino acid or amino acid derivative is to be added and, as a result, it has been found that a stable thromboplastin reagent having no reduction in the activity by freeze-drying can be provided whereupon the present invention has been achieved.

Thus, the present invention comprises the followings.

1. A method for the manufacture of a thromboplastin reagent which is characterized in that, in the manufacturing steps of thromboplastin reagent, there is included a step where an effective amount of amino acid or derivative thereof having such a function that an ISI (international sensitivity index) of a thromboplastin-containing composition showing an ISI of more than 1.0 is made nearer 1.0 is added.

2. The method according to the above 1, wherein, as the effective amount of amino acid or derivative thereof mentioned

in the above 1, it is added so as to make the final concentration 0.01-20 w/v%.

3. The method according to the above 1 or 2, wherein the amino acid or derivative thereof mentioned in the above 1 is glutamic acid, sodium glutamate or glycine.

4. The method according to any of the above 1 to 3, wherein the step of addition of the amino acid or derivative thereof is after the step for the extraction of thromboplastin from the material composition and is before the freeze-drying.

5. The method according to any of the above 1 to 3, wherein the step of addition of the amino acid or derivative thereof is after the step for the extraction of thromboplastin from the material composition and for the freeze-drying.

6. A thromboplastin reagent which is manufactured by any of the methods mentioned in the above 1 to 5.

7. A thromboplastin reagent, characterized in that, there is contained an effective amount of an amino acid or derivative thereof which has a function that an ISI (international sensitivity index) of a thromboplastin-containing composition showing an ISI of more than 1.0 is made nearer 1.0.

8. The thromboplastin reagent according to the above 7, wherein, as the effective amount of amino acid or derivative thereof mentioned in the above 7, it is added so as to make the final concentration 0.01-20 w/v%.

9. The thromboplastin reagent according to the above 7

or 8, wherein the amino acid or derivative thereof mentioned in the above 7 is glutamic acid, sodium glutamate or glycine.

10. A kit for the measurement of coagulation time containing the thromboplastin reagent described in any of the above 6 to 9.

Detailed Description of the Preferred Embodiments

INR (international normalized ratio) is used as a new way of describing a PT. The INR value is calculated by rising to ISI power of a prothrombin ratio (PR) and its normal value is 1.0. Here, a prothrombin ratio is the ratio of the PT of normal plasma to the PT of patient plasma and is expressed by PR.

The relation between INR and ISI is given by the following formula.

$INR = PR^{ISI} = [(PT \text{ of patient plasma})/(PT \text{ of normal plasma})]^{ISI}$ $\frac{20}{1} = 20$ $\frac{PP}{NP} = \frac{20}{10} = 2$ larger INR, better reagents

Thus, when the ISI value is high in a thromboplastin reagent, it is a reagent where the difference between the PT of normal plasma and the PT of plasma deficient in a coagulation factor is little while, when the ISI value therein is low, it is a reagent where the difference between the PT of normal plasma and the PT of plasma deficient in a coagulation factor is large. Therefore, it is believed that, when the PT changes depending upon the amount of the coagulation factor contained therein, amount of the coagulation factor can be measured with a good

precision.

At present, various kinds of thromboplastin-containing compositions extracted from human placenta, rabbit brain, bovine brain, etc. are used as bulk materials for thromboplastin reagent and most of such compositions show an ISI of more than 1.0. Thus, when the ISI is made nearer 1.0, it is possible to provide a thromboplastin reagent having a suitable sensitivity. Such a way of thinking is not limited to a thromboplastin reagent derived from natural substances only but is applicable to thromboplastin reagents prepared by means of a recombinant technology as well. In the present invention, a thromboplastin-containing composition may be anything so far as it contains thromboplastin and there is no limitation for its source. For example, thromboplastin (tissue factor)-containing compositions not only derived from natural substances such as human placenta, rabbit brain and bovine brain but also prepared by means of a recombinant technology, etc. are included.

An amino acid or derivative thereof having a function of making an ISI of a thromboplastin-containing composition which has an ISI of more than 1.0 nearer 1.0 is a substance which has a function of lowering the ISI value to make nearer 1.0 when an appropriate amount is added to a thromboplastin composition and it stands for an amino acid or derivative thereof. Examples of the amino acid or derivative thereof having such a function

are alanine, aminobutyric acid (hereinafter, referred to as "ABA"), glutamic acid, glutamine, sodium glutamate, glycine, methionine, proline, serine and tyrosine. Preferably, they are alanine, aminobutyric acid, sodium glutamate, glutamic acid or glycine. And a more preferred example is sodium glutamate, glutamic acid or glycine.

With regard to an effective amount of the amino acid or derivative thereof having the above-mentioned function, there is no particular limitation so far as it is an amount achieving a function whereby the ISI value is lowered to make nearer 1.0. For example, in terms of the final concentration in a thromboplastin reagent, a range of 0.01-20 w/v%, preferably 0.1-10 w/v% or, more preferably, 0.5-5 w/v% may be exemplified.

The amino acid or derivative thereof having the above-mentioned function may be added at any stage during the manufacturing steps and there is no particular limitation therefor. It is also possible that, after being prepared as a reagent composition, the above-mentioned effective amount is added. Especially when the amino acid or derivative thereof having the above-mentioned function is added with an object of preventing the reduction of activity caused by the so-called freeze-drying, it is preferred to add prior to the freeze-drying during the manufacturing steps.

In addition to the freeze-dried product, the thromboplastin reagent of the present invention may be in a form

of a liquid product or a frozen product.

Examples

The present invention will now be further illustrated by way of the following Examples although the present invention is not limited thereto.

Example 1.

PT values when various concentrations of various kinds of amino acid or derivatives thereof were added to thromboplastin bulk solution (derived from rabbit brain) prepared by a method described in Japanese Patent Laid-Open No. 05/60,762 were measured and then ISI value for each of the sample was determined on the basis of calibration plasma where an INR was previously regulated.

Measurement of the PT was carried out according to a known measuring method.

To be more specific, measurement was conducted by the following method. Thus, each of various amino acids or amino acid derivatives was added to a thromboplastin bulk solution so as to make its final concentration 1, 2 or 3 w/v%, then a calcium salt was added thereto to make its final concentration 10 mM and the mixture was freeze-dried to give a thromboplastin sample. Calibration plasma (0.05 ml) was pipeted and incubated at 37°C for about 1 minute. To this was added 0.1 ml of a thromboplastin reagent solution which was previously

reconstituted in pure water and mixed with calcium in a concentration of 10 mM incubated at 37°C and then PT was measured using a Coagrex-700 (an automated coagulation analyzer; manufactured by Shimadzu).

An ISI value of each thromboplastin sample solution was determined from the measured PT value and the INR value of the calibration plasma and influence of each additive on ISI was tested.

The result was shown in Table 1.

As a result, with regard to a calibration plasma (AK-A), PT was shortened in all cases where a thromboplastin reagent to which amino acid or derivative thereof was added was used as compared with the case of the use of thromboplastin reagent to which no additive was added. Thus, it is likely that, when various additives are added to a thromboplastin bulk reagent, the so-called reduction in the activity by freeze-drying can be prevented whereby it is possible to provide a reagent having a high stability.

In the case of a calibration plasma (AK-D), PT was prolonged except the case where 1% alanine was added. It suggests that PT is elongated depending upon a reduction in the content of the coagulation factor contained in the calibration plasmas (AK-A~D) and accordingly that measurement with better sensitivity is possible.

The ISI value of each thromboplastin reagent was smaller

in all cases than the ISI value of a thromboplastin to which no additive was added.

Table 1

Prothrombin Time (PT) and ISI Values

when Various Additives were Added

(PT: seconds)

	INR	Nothing Added	1% Glu・Na	2% Glu・Na	3% Glu・Na
AK-A	1.04	14.3	13.6	13.5	13.9
AK-B	1.92	20.4	20.8	21.7	23.4
AK-C	3.07	27.1	28.4	30.1	33.5
AK-D	4.37	33.3	35.8	37.6	41.5
ISI =		1.69	1.48	1.4	1.3

	INR	Nothing Added	1% Ala	2% Ala	3% Ala
AK-A	1.04	14.3	13.5	13.9	13.6
AK-B	1.92	20.4	19.9	20.9	20.6
AK-C	3.07	27.1	27.1	28.2	28.3
AK-D	4.37	33.3	33.1	34.8	35.3
ISI =		1.69	1.59	1.56	1.5

	INR	Nothing	1% ABA	2% ABA	3% ABA

		Added			
AK-A	1.04	14.3	13.5	13.6	13.5
AK-B	1.92	20.4	20.3	20.9	21.0
AK-C	3.07	27.1	27.4	27.8	28.4
AK-D	4.37	33.3	34.2	34.6	35.3
ISI =		1.69	1.54	1.54	1.49

Each of AK-A, B, C and D is calibration plasma and has an intrinsic INR value.

ISI value for each sample was calculated from the measured PT value and the calibration plasma INR value for each sample.

Example 2.

PT was measured for the case where sodium glutamate was added as an additive to a thromboplastin bulk solution to such an extent that its final concentration was 1, 2, 3, 4 or 5 w/v% and then an ISI value was determined.

Measurement of PT and calculation of ISI value were carried out in the same manner as in Example 1.

The result was shown in Table 2.

Table 2

Prothrombin Time (PT) and ISI Values when Various Concentrations of Sodium Glutamate were Added

(PT: seconds)

	INR	Nothing Added	1% Glu・Na	2% Glu・Na	3% Glu・Na	4% Glu・Na	5% Glu ・Na
AK-A	1.04	14.7	14.3	14.0	14.0	14.8	15.5
AK-B	1.92	20.5	21.6	22.4	24.7	25.9	28.7
AK-C	3.07	28.0	30.2	31.5	35.5	38.8	41.8
AK-D	4.37	35.2	38.6	41.2	46.4	50.4	57.5
	ISI =	1.64	1.44	1.33	1.2	1.16	1.1

Each of AK-A, B, C and D is calibration plasma and has an intrinsic INR value.

ISI value for each sample was calculated from the measured PT value and the calibration plasma INR value for each sample.

The ISI value for each thromboplastin sample became small depending upon the concentration of sodium glutamate and an improvement in the sensitivity of each thromboplastin sample was noted.

On the other hand, the PT for the amended plasma (AK-A) was shortest when 2 w/v% or 3 w/v% of sodium glutamate was added to give a thromboplastin reagent having a high stability.

As fully illustrated hereinabove, it is now possible to provide a thromboplastin reagent having a high measurement sensitivity and a high stability when, in the manufacturing steps of thromboplastin reagent, there is included a step where

an effective amount of amino acid or derivative thereof having such a function that an ISI (international sensitivity index) of a composition of thromboplastin showing an ISI of more than 1.0 is made nearer 1.0 is added.